

CO10787-00053

Region 8



9042

(1 OF 2)

CO00053

204

PRIV

204-079 10787

205a(1) UIC - CO-00053 - PERMIT, NON  
HOVE;WEEP H'WD-1

Fldr #: 9042

PART I. AUTHORIZATION TO INJECT

Pursuant to the Underground Injection Control Regulations of the U.S. Environmental Protection Agency codified at Title 40 of the Code of Federal Regulations, Parts 124, 144, 146 and 147,

SHELL WESTERN E&P INC.  
Subsidiary of Shell Oil Company  
Post Office Box 576  
Houston, Texas 77001

is hereby authorized to operate a Class I injection well, commonly known as Hoverweep (HWD-1) located at 300 feet from South line and 515 feet from East line of Section 9, Township 38N, Range 18W of Montezuma County, Colorado. Injection shall be for the purpose of industrial waste fluid disposal into the Leadville Limestone and Ouray Formation, in accordance with conditions set forth herein.

Permit authorization shall not commence until the operator has fulfilled and verified with the Director all applicable conditions of this permit. "Transition from Rule to Permit Authorization" requirements are set forth in Part II, Section C. 1. of this permit.

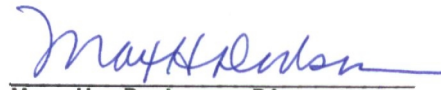
All conditions set forth herein refer to Title 40 Parts 144, 146, and 147 of the Code of Federal Regulations and are regulations that are in effect on the date that this permit is effective.

This permit consists of a total of 30 pages and includes all items listed in the Table of Contents. Further, it is based upon representations made by the permittee and on other information contained or referenced in the Administrative Record. It is the permittee's responsibility to read and understand all provisions of this permit.

This permit and the authorization to inject are issued for ten (10) years, unless terminated. The permit will be reviewed by EPA at least every five years to determine whether action under 40 CFR 144.36 (a) is warranted. The permit will expire at midnight February 6, 1997, or upon delegation of primary enforcement responsibility for the UIC-1422 Program to the State of Colorado, unless that State has adequate authority and chooses to adopt and enforce this permit as a State permit.

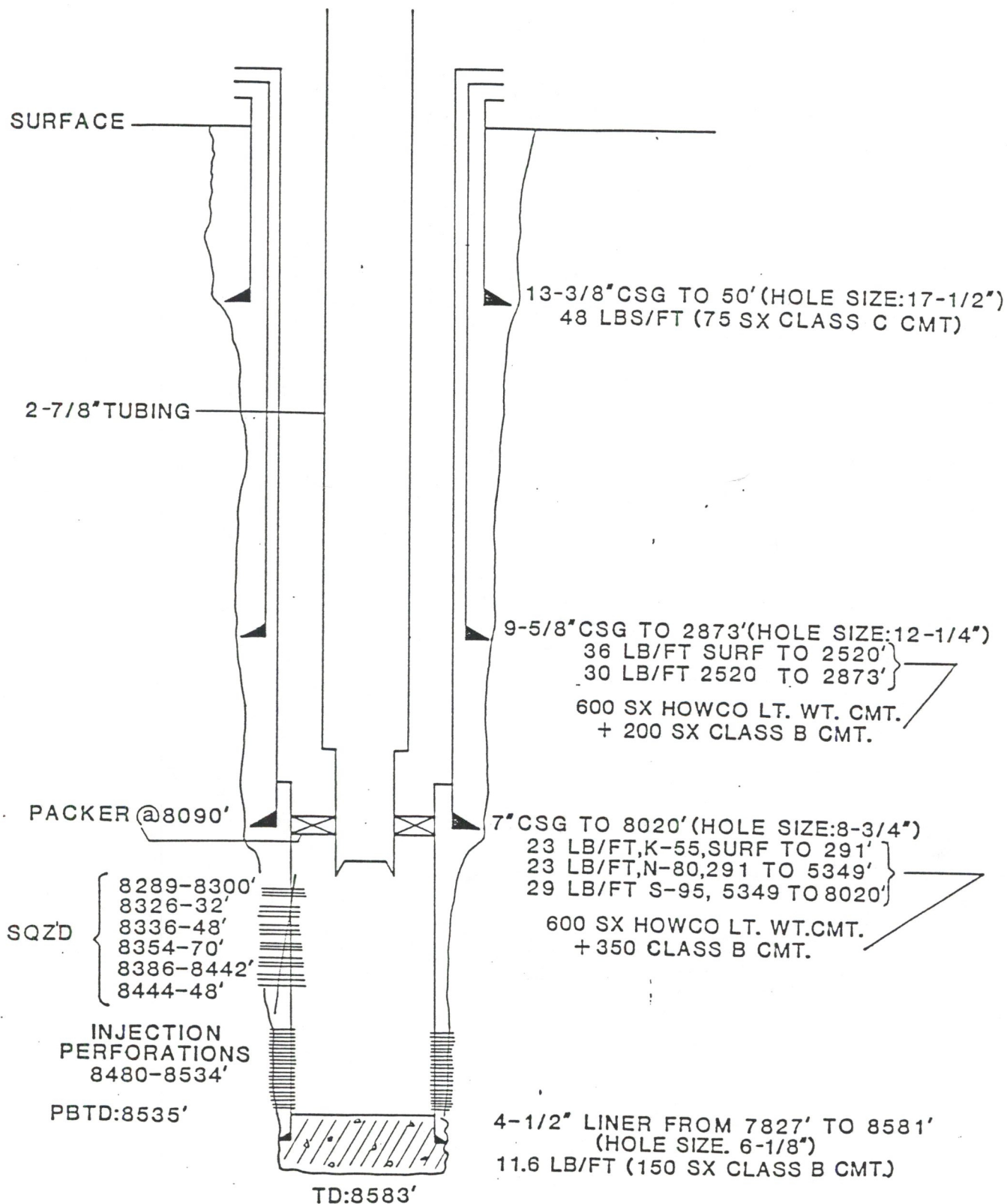
Issued this 6th day of February, 1987.

This permit becomes effective March 8, 1987.

  
Max H. Dodson, Director  
Water Management Division \*

\* NOTE: The person holding this title is referred to as the "Director" throughout this permit.

# CONSTRUCTION DETAILS OF HWD-1



The draft permit contains a condition which states that EPA may with due cause, modify, revoke and reissue, or terminate the permit in accordance with Federal regulations, including if and when revisions or amendments to the Safe Drinking Water Act (SDWA) are made.

g. Injection Zone Hydrogeology

The injection zone is in the Leadville Limestone of Mississippian age and the Devonian age Ouray Formation. The Leadville Limestone occurs at a depth of 8,230 feet from surface and is 284 feet thick. The Ouray Formation is at 8,514 feet from surface and is not penetrated through the entire formation (TD is 8,583 feet; PBD is 8,535 feet). Lithology of the Leadville Limestone is limestone, often oolitic and fossiliferous, changing to dolomite in the lower half of the unit. The Ouray Formation is limestone and dolomite with occasional streaks of gray-green waxy shale.

Both formations are perforated in the interval of 8,480-8,534 feet from surface. Hydrogeologic parameters for this interval are:

Porosity = 8%

Permeability = 2.7 md

Fluid pressure = 2,500 psi

Fracture pressure = 4,330 psi

Bottom hole pressure = 3,220 psi at 3 BPM

Bottom Hole temperature = 180° F

Total Dissolved Solids (TDS) ranges from 3,000 - 100,000 ppm, depending on the location of the gas water interface ("Free water" is the higher TDS value).

h. Confining Zone Hydrogeology

The overlying Molas Formation has been described as the confining zone for the Woods #3 (MWD-1) well which is also in the McElmo Dome Field. Because of the consistency in geology across the McElmo Dome field, the Molas Formation shall be considered the confining zone for the entire Hovenweep well as well. The Molas Formation is a Pennsylvanian age redbed, consisting of interbedded red siltstone and sandstone, light colored limestone and varicolored shales. This formation was evaluated by electric logs to estimate its petrophysical properties. These logs included a Borehole Compensated Sonic Log, a Compensated Neutron Log, a Formation Density Log, a Dual Laterolog and microlaterolog-microlog. The interpretation of these logs showed the formation to be approximately 114 feet thick. The shales and siltstones of the Molas Formation have apparent log porosity but are impermeable. The limestone intervals are tight, with porosity less than two percent.

Other shale formations between the injection zone and the lowermost possible USDW include the Cutler Formation, the Moenkopi Formation and the Chinle Formation. These three units are considered redbeds and have low permeabilities. The Chinle Formation is 706' thick, the Moenkopi Formation is 49' thick and the Cutler Formation is 1,777' thick. Calculations of TDS concentrations using resistivity logs have shown the Chinle and Cutler Formations not to be USDW's, although they are water bearing and produce water elsewhere in the region.

i. Local Groundwater Utilization

Except for this facility, there are no known wells penetrating the injection zone within the area of review. The deepest water well (680 feet) is located in Township 38N, Range 18W. Water production is from the Dakota Sandstone and possibly the Salt Wash Member, of the Morrison Formation. Other potential fresh water bearing units were identified, in the report titled Mineral and Water Resources of Colorado in Water Resources, by J.W. Odell, D.L. Coffin, and R.H. Langford (1964), as "... in order of importance are, the Dakota Sandstone, of Cretaceous age. The Entrada and Junction Creek Sandstone and the Salt Wash Member of the Morrison Formation, all of Jurassic age; and the Wingate Sandstone of Triassic age. Older rocks generally yield no water or water that is too highly mineralized for ordinary uses."

The report titled Atlas of Ground Water Quality in Colorado by F.N. Repplier, E.C. Healy, D.B. Collins and P.A. Longmire (1981), shows ground water production from the Cretaceous age Dakota Sandstone with water quality of 1,410 ppm TDS. This water well is over 10 miles to the east of the disposal well. There is also water production from the Jurassic age Morrison Formation, of 1,450 ppm TDS water, 15 miles to the south. All of the known and potential water bearing formations are hydrogeologically isolated from the injection zone by 1) the identified confining layer, 2) cement in the wellbore, and 3) approximately 2,000 feet of other redbeds and shale.

John Romero, Supervisory Water Resource Engineer, for the Colorado Department of Natural Resources, researched the water resources of the subsurface around the McElmo Dome Unit. Known or suspected aquifers in the area are surficial deposits, the Dakota and Burro Canyon Formations, Salt Wash member of the Morrison Formation, the Junction Creek and Entrada Sandstone and (possibly) the Chinle Formation. The underlying Cutler and Rico Formations have aquifer potential but definitive data are lacking, (Romero, 1985). However, as discussed in Section 10. a. 1. of this Fact Sheet, estimates of TDS in the Cutler indicates that the Cutler is not a USDW.

2. PHYSICAL SETTING

a. Structural Geology

The Hovenweep (HWD-1) well is located on the eastern flank of the Colorado Plateau physiographic province. This province is characterized by thick sequences of sediments which have been structurally stable since Precambrian time. Major geologic events, in more recent time (Tertiary), include the intrusion of laccolithic stocks such as the Sleeping Ute Mountain. This volcanic/plutonic rock body provided the heat source that caused the Leadville Limestone to alter and produce CO<sub>2</sub> gas, which accumulated in economic quantities in the McElmo Dome area.

b. Stratigraphy

The Colorado Plateau is characterized by thick sedimentary sequences and a tectonically stable environment since Precambrian time. The stratigraphic units, penetrated by the Hovenweep (HWD-1) well, are shown in the appendix to this Fact Sheet.

c. Hydrogeology

Hydrogeologic horizons have been identified (in the reports referenced or included in the Administrative Record) to be surficial deposits which are normally less than 20 feet thick except along valley bottoms. No water wells utilize these types of deposits in the area, (Romero, 1985). "Dakota Sandstone, Burro Canyon, and Salt Wash Member strata are known aquifers in other areas and probably have water yielding properties in Section 16. The Junction Creek and Entrada Sandstones are known aquifers and a well about three miles to the east in Section 13 probably taps one or both of these sandstones. Geologic units below the Entrada and above the Hermosa (Navajo, Wingate, Chinle) yield small quantities of water to wells in other areas, but nothing is known of their water yielding potential in the vicinity of the McElmo Dome Unit application", (Romero, 1985), [See appendix for depths to rock units penetrated by the Hovenweep wellbore).

The Leadville/Ouray formation water quality is quite variable. The TDS concentration ranges from 3,000 ppm to over 100,000 ppm depending where the water sample is taken. The lower TDS values are drawn from above the gas-water interface, where the water is in vapor form and drops out as condensation, with the change in pressure and temperature when the gas is produced. The higher TDS concentrations come from below the gas-water interface where "free water" is occurring. The injection zone, in the permit application, was shown to have a TDS concentration of 78,727 ppm. The injected fluid has a TDS concentration of 3,155 ppm, the porosity of the zone is 8% with a permeability of 2.7 millidarcy (md).

3. WELL CONSTRUCTION

The SWEPI Hovenweep (HWD-1) well was spudded November 21, 1978, and total depth (TD) was reached January 14, 1979. The well was initially drilled as a CO<sub>2</sub> exploratory well but the well was found to be uneconomical for CO<sub>2</sub> production. The well was originally perforated at 8289 - 8448 feet for testing productivity. On November 11, 1983, this interval was cement squeezed with 150 sacks of class H cement and production was abandoned. The well was re-perforated at 8580 - 8534 feet on November 21, 1983 and stimulated with 125 bbls of 15% hydrochloric acid. An injectivity test and pressure test to 1000 psi were performed on December 2, 1983. It was completed for injection purposes on December 6, 1983.

## ATTACHMENTS TO COMPLETION REPORT HWD-1

### I. Geologic Information

#### 1. Lithology and Stratigraphy

##### A. Description of Rock Units Penetrated

Name: Dakota  
Age: Cretaceous  
Depth: Outcrops at surface  
Thickness: 570'  
Lithology: Light gray sandstone and carbonaceous shale

Name: Morrison  
Age: Jurassic  
Depth: 570'  
Thickness: 190'  
Lithology: Light Gray to pink sandstone and green or red mudstone

Name: Bluff  
Age: Jurassic  
Depth: 760'  
Thickness: 265;  
Lithology: Gray to buff sandstone

Name: Summerville  
Age: Jurassic  
Depth: 1025'  
Thickness: 118'  
Lithology: Red, sand mudstone, red sandstone and minor chert

Name: Entrada  
Age: Jurassic  
Depth: 1143'  
Thickness: 105'  
Lithology: Light buff, reddish brown or salmon colored fine-grained sandstone

Name: Carmel  
Age: Jurassic  
Depth: 1248'  
Thickness: 17'  
Lithology: Reddish brown sandy siltstone and silty sandstone

Name: Navajo  
Age: Jurassic  
Depth: 1265'  
Thickness: 133'  
Lithology: Buff to pale orange cross-bedded sandstone

Name: Kayenta  
Age: Triassic  
Depth: 1398'  
Thickness: 42'  
Lithology: Reddish sandstone and interbeds of red or green mudstone

Name: Wingate  
Age: Triassic  
Depth: 1440'  
Thickness: 510'  
Lithology: Pale orange and brown, fine-grained sandstone

Name: Chinle  
Age: Triassic  
Depth: 1950'  
Thickness: 706'  
Lithology: Reddish brown siltstone and sandstone, reddish brown to variegated bentonitic mudstone, and minor gray conglomeratic sandstone

Name: Moenkopi  
Age: Triassic  
Depth: 2656'  
Thickness: 49'  
Lithology: Reddish brown laminated siltstone, sandy siltstone and minor very fine-grained sandstone

Name: Cutler  
Age: Permian  
Depth: 2705'  
Thickness: 1777'  
Lithology: Interbedded red, orange, and purple sandstones, siltstones and shales

Name: Honaker Trail  
Age: Pennsylvanian  
Depth: 4482'  
Thickness: 1028'  
Lithology: Interbedded gray sandstones, limestones and shales with scattered amounts of gray and orange chert.

Name: Paradox  
 Age: Pennsylvanian.  
 Depth: 5510'  
 Thickness: 2460'  
 Lithology: Interbedded salt, anhydrite, dark colored dolomites and black shale

Name: Pinkerton Trail  
 Age: Pennsylvanian  
 Depth: 7970'  
 Thickness: 146'  
 Lithology: Light gray limestones and gray to gray-green shales, siltstones and sandstones

Name: Molas  
 Age: Pennsylvanian  
 Depth: 8116'  
 Thickness: 114'  
 Lithology: Interbedded red siltstones, sandstones, light colored limestones and varicolored shales

Name: Leadville  
 Age: Mississippian  
 Depth: 8230'  
 Thickness: 284'  
 Lithology: Limestone, often oolitic and fossiliferous changing to dolomite in the lower half

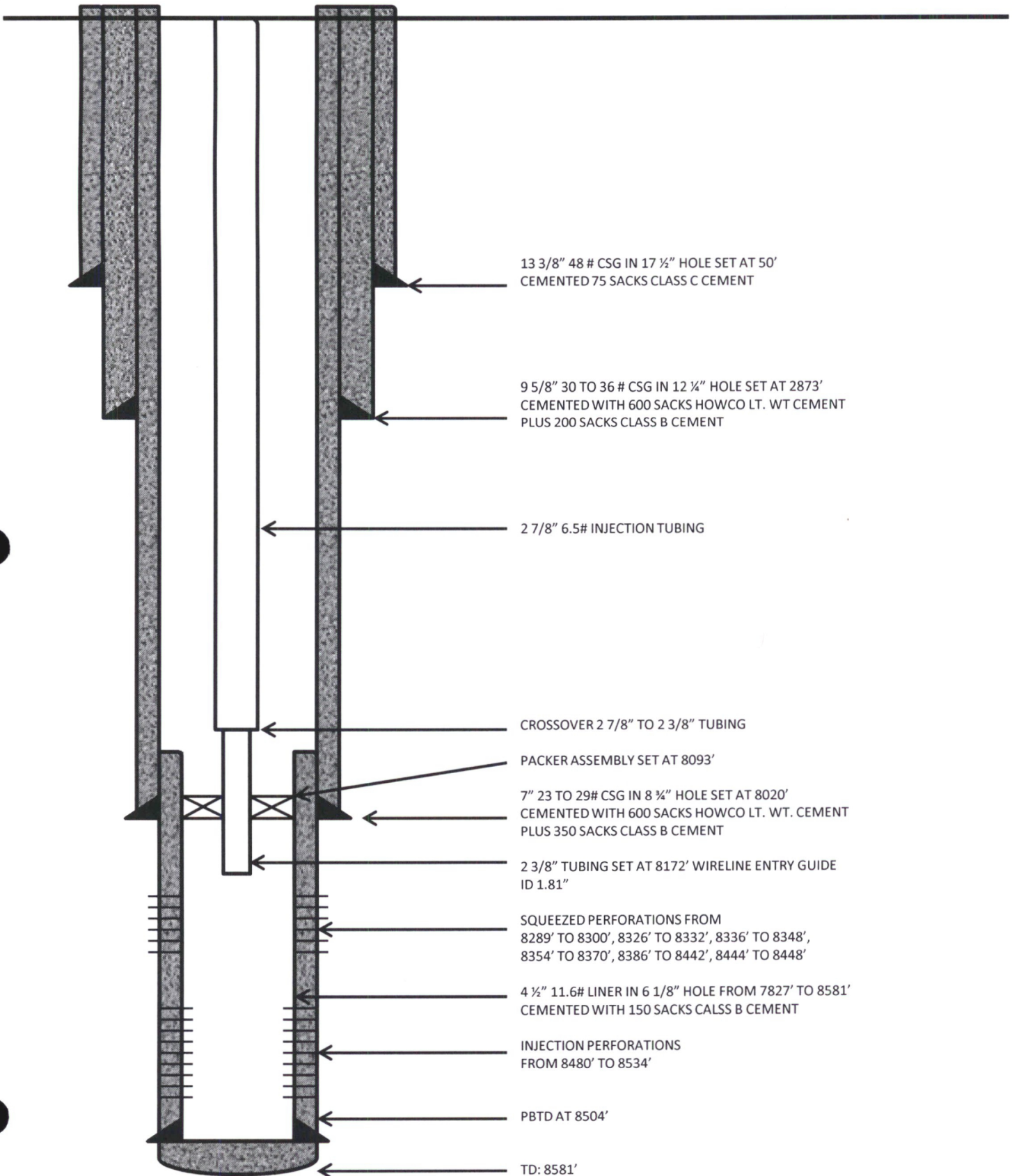
Name: Ouray  
 Age: Devonian  
 Depth: 8514'  
 Thickness: NP  
 Lithology: Limestone and dolomite with occasional streaks of gray-green waxy shale

#### B. Description of Injection Unit

Name: Leadville  
 Depth: 8230'  
 Thickness: 284'  
 Fluid Pressure: 2500 psi  
 Age: Mississippian  
 Porosity: 8%  
 Permeability: 2.7 md  
 Bottom hole temperature: 180°F  
 Lithology: Limestone and Dolomite  
 Bottom hole pressure: 3220 psi @ 3 BPM  
 Fracture pressure: 4330 psi

FIGURE 2-1

KINDER MORGAN CO<sub>2</sub> COMPANY, LP  
HOVENWEEP HWD-1 EPA PERMIT NO. COS12ME-0042  
CORTEZ, COLORADO, MONTEZUMA, COUNTY

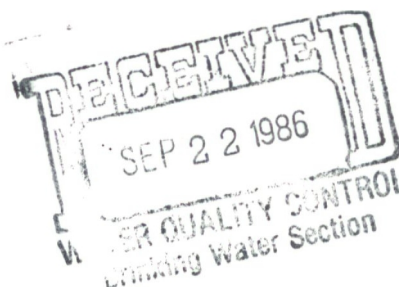


# Rocky Mountain Analytical Laboratory

4955 Yarrow Street, Arvada, CO 80002 (303) 421-6611

A DIVISION OF  
**ENSECO**  
INCORPORATED

September 10, 1986



A. L. Pittman  
Shell Western E & P, Inc.  
P.O. Box 748  
Lewis, CO 81327

Dear Larry:

Enclosed are the results for the analysis of the six water samples received August 6 and 7, 1986. Attached is Appendix A detailing the results for the compatibility study. Also enclosed is a list of standard methodologies and nominal detection limits. No satisfactory method is available for the analysis of glycol. TOX values may be suspect in some of the samples due to the high concentrations of inorganic chloride.

Please do not hesitate to call if you have any questions.

Sincerely,

Brian J. Rahn  
Project Coordinator  
Inorganic Chemistry

Approved by:

Jerry L. Parr  
Technical Director

BJR/JLP/bj  
Enclosures

RMAL #61862

# Rocky Mountain Analytical Laboratory

4955 Yarrow Street, Arvada, CO 80002 (303) 421-6611

A DIVISION OF  
ENSECO  
INCORPORATED

September 11, 1986

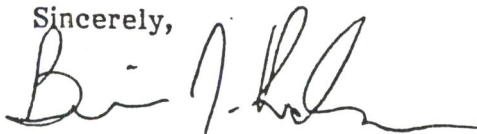
A. L. Pittman  
Shell Western E & P, Inc.  
P.O. Box 748  
Lewis, CO 81327

Dear Larry:

Enclosed is a revised report with the correct units for the Radiochemistry analysis. I apologize for any inconvenience this may have caused.

Please do not hesitate to call if you have any questions.

Sincerely,



Brian J. Rahn  
Project Coordinator  
Inorganic Chemistry

BJR/bj  
Enclosures

RMAL #61862

## SAMPLE DESCRIPTION INFORMATION

for

Shell Western E & P, Inc.

<u>RMA Sample No.</u>	<u>Sample Description</u>	<u>Sample Type</u>	<u>Date Sampled</u>	<u>Date Received</u>
61862-01	Hovenweep Disposal Water	Water	08/04/86	08/06/86
61862-02	YA Produced Water	Water	08/04/86	08/06/86
	Yellow Jacket Facility			
61862-03	HA Produced Water	Water	08/04/86	08/06/86
	Hovenweep Facility			
61862-04	Moqui Produced Water	Water	08/05/86	08/06/86
61862-05	Moqui Disposal Water	Water	08/05/86	08/06/86
61862-06	Yellow Jacket Disposal	Water	08/06/86	08/07/86
	Water			

September 11, 1986

## ANALYTICAL RESULTS

for

Shell Western E & P, Inc.

## RADIOCHEMISTRY

<u>Parameter</u>	<u>Units</u>	<i>H- D3P</i> <u>61862-01</u>	<i>H- Prod.</i> <u>61862-02</u>	<u>61862-03</u>	<u>61862-04</u>
Radium 226	pCi/L	13 ± 3	4.1 ± 1	160 ± 10	9.4 ± 2.6
Radium 228	pCi/L	0.0 ± 4	0.0 ± 4	4.7 ± 5	0.0 ± 4
Gross alpha	pCi/L	23 ± 11	15 ± 4	340 ± 150	21 ± 14
Gross beta	pCi/L	30 ± 9	0.0 ± 6.8	530 ± 170	65 ± 21

<u>Parameter</u>	<u>Units</u>	<u>61862-05</u>	<u>61862-06</u>
Radium 226	pCi/L	7.5 ± 2.3	2.1 ± 1.3
Radium 228	pCi/L	0.0 ± 5	0.0 ± 5
Gross alpha	pCi/L	21 ± 19	7.6 ± 5.8
Gross beta	pCi/L	97 ± 24	15 ± 8

## ANALYTICAL RESULTS

for

Shell Western E & P, Inc.

## INORGANIC PARAMETERS

Parameter	Units	61862-01		61862-02		61862-03		61862-04	
pH	units	5.75	(0.01)	3.99	(0.01)	6.49	(0.01)	5.82	(0.01)
Specific Conductance at 25°C	umhos/cm	7160	(1)	180	(1)	22800	(1)	3680	(1)
Total Dissolved Solids	mg/L	4690	(10)	180	(10)	13200	(10)	2440	(10)
Chloride	mg/L	2130	(3)	36	(3)	8440	(3)	820	(3)
Nitrate + Nitrite as N	mg/L	ND	(0.1)	ND	(0.1)	0.2	(0.1)	ND	(0.1)
Sulfate	mg/L	142	(5)	ND	(5)	836	(5)	146	(5)
Total Organic Carbon	mg/L	240	(0.1)	12	(0.1)	15	(0.1)	49	(0.1)
Total Organic Halogen	ugCl <sup>-</sup> /L	30	(5)	5	(5)	180	(5)	7	(5)
Oil and Grease	mg/L	18	(0.5)	ND	(0.5)	ND	(0.5)	2	(0.5)
Fecal Coliform	col./100 mL	ND	(1)	ND	(1)	ND	(1)	ND	(1)
Total Coliform	col./100 mL	ND	(1)	ND	(1)	ND	(1)	ND	(1)
Hexavalent Chromium	mg/L	0.05	(0.01)	0.01	(0.01)	0.07	(0.01)	0.02	(0.01)
Specific Gravity at 80°F	units	1.0023	(0.0001)	0.9968	(0.0001)	1.0107	(0.0001)	0.9977	(0.0001)
Compatibility*									

Parameter	Units	61862-05		61862-06	
pH	units	5.86	(0.01)	5.00	(0.01)
Specific Conductance at 25°C	umhos/cm	3570	(1)	1190	(1)
Total Dissolved Solids	mg/L	2420	(10)	1000	(10)
Chloride	mg/L	907	(3)	281	(3)
Nitrate + Nitrite as N	mg/L	ND	(0.1)	ND	(0.1)
Sulfate	mg/L	125	(5)	12	(5)
Total Organic Carbon	mg/L	51	(0.1)	110	(0.1)
Total Organic Halogen	ugCl <sup>-</sup> /L	460	(5)	78	(5)
Oil and Grease	mg/L	47	(0.5)	90	(0.5)
Fecal Coliform	col./100 mL	ND	(1)	ND	(1)
Total Coliform	col./100 mL	ND	(1)	ND	(1)
Hexavalent Chromium	mg/L	ND	(0.01)	0.04	(0.01)
Specific Gravity at 80°F	units	1.0003	(0.0001)	1.0001	(0.0001)
Compatibility*					

\*See Appendix A

ND = Not detected. Detection limits in parentheses.

## ANALYTICAL RESULTS

for

Shell Western E & P, Inc.

## TRACE METALS

<u>Parameter</u>	<u>Units</u>	<u>61862-01</u>		<u>61862-02</u>		<u>61862-03</u>		<u>61862-04</u>	
Barium	mg/L	0.020	(0.005)	0.55	(0.005)	0.085	(0.025)	0.021	(0.005)
Calcium	mg/L	89	(0.1)	14	(0.1)	657	(0.5)	178	(0.1)
Chromium	mg/L	0.58	(0.005)	0.29	(0.005)	0.10	(0.025)	0.30	(0.005)
Iron	mg/L	10	(0.05)	4.2	(0.05)	3.2	(0.25)	6.6	(0.05)
Magnesium	mg/L	28	(0.1)	5.5	(0.1)	68	(0.5)	44	(0.1)
Potassium	mg/L	21	(0.3)	ND	(0.3)	591	(1.5)	80	(0.3)
Sodium	mg/L	148	(0.5)	3.6	(0.5)	3980	(2.5)	58	(0.5)
Strontium	mg/L	0.14	(0.005)	0.035	(0.005)	4.2	(0.025)	0.45	(0.005)

<u>Parameter</u>	<u>Units</u>	<u>61862-05</u>		<u>61862-06</u>	
Barium	mg/L	0.038	(0.005)	0.020	(0.005)
Calcium	mg/L	296	(0.1)	91	(0.1)
Chromium	mg/L	1.1	(0.005)	0.15	(0.005)
Iron	mg/L	14	(0.05)	3.9	(0.05)
Magnesium	mg/L	106	(0.1)	37	(0.1)
Potassium	mg/L	67	(0.3)	12	(0.3)
Sodium	mg/L	187	(0.5)	12	(0.5)
Strontium	mg/L	0.59	(0.005)	0.076	(0.005)

ND = Not detected. Detection limits in parentheses.

APPENDIX A

# ERCO

2400 West Loop South, Suite 300, Houston, Texas 77027 (713) 960-9411 Telefax (713) 960-9302

A DIVISION OF  
**ENSECO**  
INCORPORATED

September 5, 1986

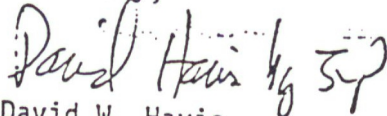
DH009

Jerry Parr  
Marketing Manager  
Rocky Mountain Analytical Lab  
4955 Yarrow Street  
Arvada, Colorado 80002

Dear Jerry:

The enclosed report contains laboratory data concerning the disposal and production water samples from Shell Western E&P Inc. Compatibility and viscosity tests show no significant precipitate formation or viscosity increase during the test period. If you have any questions, please call me.

Sincerely,



David W. Havis  
Staff Research Scientist

DH/dp

Enclosure

cc: Maurice Jones

Regional and international offices:

- 205 Alewife Brook Parkway, Cambridge, Massachusetts 02138 (617) 661-3111 Telex 650-256-7697 (MCI)
- 123 Grove Avenue, Suite 118, Cedarhurst, New York 11516 (516) 295-1162
- c/o Bectech Trading Co., Ltd., P.O. Box 101-41, Taipei, Taiwan (R.O.C.) Tel. 5013908

ENSECO, INC.  
Southern Region

Subject

Production and disposal water samples from Shell Western E&P Inc. in Cortez, Colorado.

Conclusion

No significant precipitate formation or viscosity increase was observed during the combination of production and disposal water samples. The 30-minute test period revealed no appreciable change in the water temperature of 75°F.

---

David W. Havis

September 5, 1986

Sample Identification

- |                                 |           |
|---------------------------------|-----------|
| 1. MOQUI Produced Water         | #61862-04 |
| 2. MOQUI Disposal Water         | #61862-05 |
| 3. Hovenweep Produced Water     | #61862-03 |
| 4. Hovenweep Disposal Water     | #61862-01 |
| 5. Yellow Jacket Produced Water | #61862-02 |
| 6. Yellow Jacket Disposal Water | #61862-06 |

Testing Procedure

1. Each sample acclimated to a room temperature of 75°F.
2. Before the combination of production and disposal water sample pairs, precipitate formation and individual water temperatures were recorded.
3. After mixing, sample monitoring of precipitate formation, viscosity change, and temperature fluctuations occurred at 15 minute intervals.

Test Data

Table 1: Shell Western E&P Inc. Production and Disposal Water Samples

Sample Identification	Initial Sample Volume mls.	Initial Sample Temperature °F.	Precipitate Formation	Turbidity	Color
MOQUI Produced Water 61862-04	150	75	None	None	None
MOQUI Disposal Water 61862-05	150	75	Slight, Yellow-brown	Slight	Yellow
Hovenweep Produced Water 61862-03	150	75	Slight, Yellow-brown	None	Yellow
Hovenweep Disposal Water 61862-01	150	75	Slight, White	Slight	White
Yellow Jacket Produced Water 61862-02	150	75	None	None	None
Yellow Jacket Disposal Water 61862-06	150	75	Slight, White	Slight	White

Table 2: Combination of Production and Disposal Sample Pairs

Sample Identification	Final Sample Volume mls.	Final Sample Temperature °F.	Precipitate Formation	Turbidity	Color
MOQUI	300	75	None	Slight	Yellow
Hovenweep	300	75	None	None	Clear
Yellow Jacket	300	75	None	Slight	White

Discussion

Test data shows no apparent compatibility or viscosity problems with the three pairs of production and disposal waters.

DWH/dp

# ROCKY MOUNTAIN ANALYTICAL LABORATORY

## Inorganic Analytical Methodology

<u>Parameter</u>	<u>Units</u>	<u>Nominal Detection Limit<sup>a</sup></u>	<u>Methodology</u>	<u>Reference</u>	<u>Preservation Bottle No.</u>	<u>Maximum Holding Time<sup>b</sup></u>
<b>MAJOR IONS</b>						
Sodium	mg/l	0.5	ICP Emission Spectroscopy	3	4	6 months
Potassium	mg/l	0.3	ICP Emission Spectroscopy	3	4	6 months
Calcium	mg/l	0.1	ICP Emission Spectroscopy	3	4	6 months
Magnesium	mg/l	0.1	ICP Emission Spectroscopy	3	4	6 months
Chloride	mg/l	3	Manual Titrimetric, Hg (NO <sub>3</sub> ) <sub>2</sub> Automated Colorimetric	1-325.3/2-407B	1	28 days
			Ferricyanide	1-325.2	1	28 days
Fluoride	mg/l	0.1	Electrode	1-340.2/2-413B	1	28 days
Sulfate	mg/l	5	Manual Turbidimetric	1-375.4/2-426C	1	28 days
			Automated Colorimetric MTB	1-375.2	1	28 days
Total Alkalinity as CaCO <sub>3</sub> at pH 4.5	mg/l	5	Titrimetric	1-310.1/2-403	1	14 days
Carbonate Alkalinity as CaCO <sub>3</sub> at pH 8.3	mg/l	5	Titrimetric	1-310.1/2-403	1	14 days
Bicarbonate Alkalinity as CaCO <sub>3</sub> at pH 4.5	mg/l	5	Titrimetric	1-310.1/2-403	1	14 days
Hydroxide Alkalinity as CaCO <sub>3</sub>	mg/l	5	Calculation	2-403	-	-
Nitrate+Nitrite as N	mg/l	0.1	Manual Cd Reduction - Colorimetric	1-353.3/2-418C	2	28 days
		0.1	Automated Cd Reduction - Colorimetric	1-353.2	2	28 days
Total Cations	meq/l	0.1	Calculation	2-104C	-	-
Total Anions	meq/l	0.1	Calculation	2-104C	-	-
Difference	%	0.1	Calculation	2-104C	-	-
<b>RADIOCHEMISTRY</b>						
Gross Alpha	pCi/l	0.1	Proportional Counter	2-703	5	6 months
Gross Beta	pCi/l	0.1	Proportional Counter	2-703	5	6 months
Radium 226	pCi/l	0.1	Separation - Counter	2-705	5	6 months
Radium 228	pCi/l	0.1	Separation - Counter	2-707	5	6 months
Uranium	mg/l	0.005	Fluorimetric	4-D2907-75	5	6 months

# ROCKY MOUNTAIN ANALYTICAL LABORATORY

## Inorganic Analytical Methodology (Continued)

<u>Parameter</u>	<u>Units</u>	<u>Nominal Detection Limit<sup>a</sup></u>	<u>Methodology</u>	<u>Reference</u>	<u>Preservation Bottle No.</u>	<u>Maximum Holding Time<sup>b</sup></u>
<b>TRACE METALS<sup>c</sup></b>						
Aluminum	mg/l	0.05	ICP Emission Spectroscopy	3	4	6 months
Antimony	mg/l	0.002	Furnace Atomic Absorption	1-204.2	4	6 months
Arsenic	mg/l	0.002	Furnace Atomic Absorption	1-206.2	4	6 months
Barium	mg/l	0.005	ICP Emission Spectroscopy	3	4	6 months
Beryllium	mg/l	0.001	ICP Emission Spectroscopy	3	4	6 months
Boron	mg/l	0.004	ICP Emission Spectroscopy	3	4	6 months
Cadmium	mg/l	0.002	ICP Emission Spectroscopy	3	4	6 months
Chromium	mg/l	0.005	ICP Emission Spectroscopy	3	4	6 months
Cobalt	mg/l	0.003	ICP Emission Spectroscopy	3	4	6 months
Copper	mg/l	0.002	ICP Emission Spectroscopy	3	4	6 months
Iron	mg/l	0.05	ICP Emission Spectroscopy	3	4	6 months
Lead	mg/l	0.025	ICP Emission Spectroscopy	3	4	6 months
		0.001	Furnace Atomic Absorption	1-239.2	4	6 months
Manganese	mg/l	0.005	ICP Emission Spectroscopy	3	4	6 months
Mercury	mg/l	0.0002	Cold Vapor Atomic Absorption	1-245.1	4	6 months
Molybdenum	mg/l	0.005	ICP Emission Spectroscopy	3	4	6 months
Nickel	mg/l	0.01	ICP Emission Spectroscopy	3	4	6 months
Selenium	mg/l	0.002	Furnace Atomic Absorption	1-270.2	4	6 months
Silver	mg/l	0.003	ICP Emission Spectroscopy	3	4	6 months
Strontium	mg/l	0.005	ICP Emission Spectroscopy	3	4	6 months
Thallium	mg/l	0.002	Furnace Atomic Absorption	1-279.2	4	6 months
Tin	mg/l	0.03	ICP Emission Spectroscopy	3	4	6 months
Titanium	mg/l	0.002	ICP Emission Spectroscopy	3	4	6 months
Vanadium	mg/l	0.002	ICP Emission Spectroscopy	3	4	6 months
Zinc	mg/l	0.004	ICP Emission Spectroscopy	3	4	6 months
<b>INORGANIC PARAMETERS</b>						
pH	units	0.01	Meter	1-150.1; 2-423	1	ASAP
Specific Conductance at 25°C	umhos/cm	1	Bridge	1-120.1; 2-205	1	28 days
Total Dissolved Solids	mg/l	10	Gravimetric, 180°C	1-160.1; 2-209B	1	7 days
Total Suspended Solids	mg/l	2	Gravimetric, 105°C	1-160.2	1	7 days
Total Solids	mg/l	10	Gravimetric, 105°C	1-160.3	1	7 days
Total Volatile Solids	mg/l	10	Gravimetric, 550°C	1-160.4	1	7 days
Ortho-Phosphate as P	mg/l	0.01	Single Reagent Colorimetric	1-365.2; 2-424F	1	48 hours

# ROCKY MOUNTAIN ANALYTICAL LABORATORY

## Inorganic Analytical Methodology (Continued)

<u>Parameter</u>	<u>Units</u>	<u>Nominal Detection Limit<sup>a</sup></u>	<u>Methodology</u>	<u>Reference</u>	<u>Preservation Bottle No.</u>	<u>Maximum Holding Time<sup>b</sup></u>
<b>INORGANIC PARAMETERS</b>						
<b>(Continued)</b>						
Total Phosphorus as P	mg/l	0.06	Digestion; ICP Emission Spectroscopy	1-4.1.4; 3	4	28 days
		0.01	Digestion - Colorimetric	1-365.2; 1-424C,F	2	28 days
Silica as SiO <sub>2</sub>	mg/l	0.1	ICP Emission Spectroscopy	3	4	28 days
	mg/l	1	Colorimetric	1-370.1; 2-425C	1	28 days
Biological Oxygen Demand	mg/l	2	Dilution Bottle - D.O. Probe	1-405.1; 2-507	1	48 hours
Chemical Oxygen Demand	mg/l	5	Micro Colorimetric	1-410.4; 2-508A	2	28 days
Total Organic Carbon	mg/l	0.1	Oxidation-Infrared Absorption	1-415.1; 2-505	2	28 days
Ammonia as N	mg/l	0.1	Electrode	1-350.3; 2-417E	2	28 days
		0.1	Automated Colorimetric	1-350.1	2	28 days
Total Kjeldahl Nitrogen as N	mg/l	0.1	Digestion - Electrode	1-351.4; 2-420B	2	28 days
		0.1	Digestion - Colorimetric	1-351.2	2	28 days
Total Organic Nitrogen as N	mg/l	0.1	Calculation (TKN - NH <sub>3</sub> )	-	-	-
Oil and Grease	mg/l	1	Freon Extraction-Gravimetric	1-413.1; 2-503A	3	28 days
Free Cyanide	mg/l	0.01	Chlorination-Distillation-Colorimetric	1-335.1; 2-412F,D	6	14 days
Total Cyanide	mg/l	0.01	Distillation - Colorimetric	1-335.2; 2-412B,D	6	14 days
Phenolics	mg/l	0.01	Distillation - Colorimetric	1-420.1; 2-510A,B	2	28 days
Fecal Coliform	Colonies/100 ml	1	Membrane Filter	2-909C	8	ASAP
Total Coliform	Colonies/100 ml	1	Membrane Filter	2-909A	8	ASAP
Bromide	mg/l	0.1	Colorimetric	2-405	1	28 days
Residual Chlorine	mg/l	0.05	Amperometric	1-330.2; 2-408C	1	ASAP
Hexavalent Chromium	mg/l	0.01	Colorimetric	1-218.4; 2-312B	1	24 hours
Color	units	5	Pt-Co Colorimetric	1-110.2; 2-204A	1	48 hours
Hardness as CaCO <sub>3</sub>	mg/l	5	Calculation	2-314A	4	6 months
Nitrite as N	mg/l	0.01	Colorimetric	1-354.1; 2-419	1	48 hours
Sulfide	mg/l	0.05	Titrimetric - Electrode	1-376.1; 2-427B,D	7	7 days
Sulfite	mg/l	2	Titrimetric	1-377.1; 2-428	1	ASAP
MBAS (Surfactants)	mg/l	0.1	Colorimetric	1-425.1; 2-512A	1	48 hours
Turbidity	NTU	0.1	Turbidimeter	1-180.1; 2-214A	1	48 hours

# ROCKY MOUNTAIN ANALYTICAL LABORATORY

## Inorganic Analytical Methodology (Continued)

### References

- (1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, EMSL, Cincinnati, 1979.
- (2) "Standard Methods for the Examination of Water and Wastewater", 15th Edition, APHA, 1980.
- (3) 40 CFR 136.3, Table II.
- (4) "Annual Book of ASTM Standards", Part 31, Water, 1980.

### Notes

<sup>a</sup>Nominal values are the best achievable with the listed analytical method. Interferences in specific samples may result in a higher detection limit.

<sup>b</sup>Applicable to NPDES wastes as updated by Robert C. Booth, Director, EMSL-Cincinnati, September 22, 1981.

<sup>c</sup>Digestion procedure 1-4.1.4 used for elements determined by ICP Emission Spectroscopy when determining total metals. Digestion procedures for graphite furnace elements included with reference listed.

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# GUIDELINES FOR SAMPLE BOTTLES AND PRESERVATIVES<sup>a, b</sup>

<u>Bottle No.</u>	<u>Parameters</u>	<u>Container</u>	<u>Preservative</u>	<u>Notes</u>
1	Cl <sup>-</sup> , F <sup>-</sup> , SO <sub>4</sub> <sup>=</sup> , Tot. Alk., CO <sub>3</sub> <sup>=</sup> Alk., HCO <sub>3</sub> <sup>-</sup> Alk., SiO <sub>2</sub> , BOD, Br <sup>-</sup> , res. Cl <sub>2</sub> , Cr <sup>+6</sup> , color, NO <sub>2</sub> <sup>-</sup> , SO <sub>3</sub> <sup>=</sup> , OH <sup>-</sup> Alk., pH, spec. cond., TDS, TSS, TS, TVS, $\varphi$ -PO <sub>4</sub> MBAS, Turbidity.	500 mL poly	4°C	Provide unfiltered sample for solids and turbidity.
2	Tot.P, COD, TOC, NH <sub>3</sub> , TKN, TON, Phenolics NO <sub>3</sub> + NO <sub>2</sub> .	1 liter glass	2 ml 50% H <sub>2</sub> SO <sub>4</sub> , 4°C	
3	O & G	1 liter glass	4 ml 50% H <sub>2</sub> SO <sub>4</sub> , 4°C	Do not filter, collect directly in bottle.
4	Na, K, Ca, Mg, A Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Sr, Tl, Sn, Ti, V, Zn, ICP, Hardness	500 ml poly	5 ml 50% HNO <sub>3</sub>	Provide separate samples for total and dissolved sample (filter before adding to bottle).
5	Alpha, Beta, Ra <sup>226</sup> , Ra <sup>228</sup> , U	1 liter poly (no Ra <sup>228</sup> ) ½ gallon poly (with Ra <sup>228</sup> )	10 ml 50% HNO <sub>3</sub> 20 ml 50% HNO <sub>3</sub>	
6	Free CN, Tot. CN	500 ml poly	2 ml 50% NaOH, 4°C	
7	Sulfide	250 ml poly	1 ml 1 N Zn acetate, 1 ml 50% NaOH, 4°C	
8	Fecal coli., total coli.	8 oz. sterile	4°C	Collect directly in sterile bottle.
11	VOA, purgeable organics, THM	3-40 ml glass vial	4°C	Completely fill bottle, leave no air bubbles.
12	B/NA	1 liter glass	4°C	
13	Pest./PCB	1 liter glass	4°C	
14	Herbicides	1 liter glass	4°C	
15	TOX	1 liter glass	4°C	

<sup>a</sup>40 CFR 136.3 Table II.

<sup>b</sup>Note: Certain other non-routine samples may require different perservation to remove interferences as specified in 40 CFR 136.3 Table II.